Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/280
UNITED STATES
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

SAFETY ASPECTS OF THE EBR-II REPROCESSING FACILITY

Milton Levenson (Argonne National Laboratory)
Charles E. Stevenson (Argonne National Laboratory)
James Hesson (Argonne National Laboratory)

The EBR-II Fuel Cycle Facility will be used to study pyrometallurgical methods of reprocessing irradiated fuel and remote methods of fuel refabrication. Substantial safety problems are always posed by the processing of irradiated fuel and the fabrication of fissionable material. Many of the problems are magnified when the material is high-burnup fuel from a high-specific-power reactor and has been cooled only 15 days. On the other hand, the compact unmoderated systems made possible by pyrometallurgy alleviates some problems. The basic safety problems of a facility such as the EBR-II Fuel Cycle Facility can be divided into four classes: shielding and radiation monitoring for personnel protection, radioactivity and contamination control, fire prevention and nuclear safety.

The shielding of the EBR-II Fuel Cycle Facility was designed to reduce the radiation to less than 0.1 milliroentgens/hour in all plant working areas. The in-cell level will be 1 000 000 roentgens/hour. After construction was completed, the entire cell structure was radiographed with a sodium-24 gamma source and with an antimony/beryllium neutron source to check the adequacy of the design. All working areas of the plant are constantly monitored for gamma background and for air-borne activity. All exhaust air from the plant is constantly monitored for gross activity, for particulate activity, for iodine activity, and for sodium-24 activity. Process off-gas is continually monitored for krypton and xenon activity. All monitoring data are automatically recorded and alarms are activated if any abnormal event occurs.

The fission products entering the facility are divided into three streams.

The first, containing krypton, xenon and tritium, is vented to the atmosphere in a controlled manner to insure that maximum permissible limits are not exceeded at any point inside or outside the plant. The second, containing the bulk of the noble-metal fission-products, is deliberately allowed to remain with the fuel (as alloying constituents) and is returned to the reactor. The third, (actually several directly produced solids) containing the iodine, rare earths and the alkaline earth metals, is confined for decay and ultimate disposal (as solids). The only routine aqueous liquid wastes containing fission products are those produced in the analytical laboratories.

Metallic fuels irradiated to 20 000 MWd/ton are in all cases self heating and in many cases pyrophoric. In addition to the fire hazard of such materials, there exists the fire hazard of the metallic sodium used in fuel fabrication and the hazards of the molten magnesium and zinc solvents used in various process operations. These hazards are virtually eliminated by carrying out all operations in an inert atmosphere of high-purity argon gas. The cell gas is over 95% argon and normally contains less that 50 parts/million of water vapor and oxygen, and less than 5% nitrogen. The cell-gas purification system is capable of reducing the oxygen and water vapor in the cell atmosphere to less than 10 parts/million. While the inert-gas atmosphere prevents fires of materials in process, it necessitates special precautions for transfer into and out of the cell so that air contamination is not introduced and so that fires do not occur after pyrophoric materials are transferred into occupied areas.

Nuclear safety - the prevention of inadvertent criticality - is one of the most serious problems of aqueous processes, but it is only a nominal problem in this facility. The safety rules of this facility permit handling of 32 kilograms of 50% enriched fuel per batch; 16 batcher may be in the cell at any one time. This is in excess of an entire reactor loading and approximately seven times the normal plant inventory. All furnaces are designed for radiation cooling rather than water cooling so that not only are aqueous solutions not utilized in processing or fabrication, but water is not present in the cell for any purpose. Similarly, all hydraulic fluids are excluded so that no fluid moderators are present in the cell. Highly flexible storage facilities are provided for in-process storage between stages or while awaiting analytical results.